ancient universities. Surely it is not asking too much of some of our most distinguished men of science that they will follow in Huxley's footsteps, and once more bring home to our schools and universities the responsibility they are incurring by their attitude towards science in the education of the well-to-do classes.

Eton, June 13. M. D. HILL.

The Rainbow.

IN "Poems by Two Brothers," written by the Tennysons, and published in 1827, is a poem called "Phrenology." The following lines occur:—

> "Shall we, with Glasgow's learned Watt, maintain
> That yon bright bow is not produced by rain?
> Or deem the theory but ill surmised,
> And call it light (as Brewster) polarised?"

Can any of your readers kindly tell me (1) what view was held by James Watt about the rainbow? (2) If Brewster was the first to point out that its light is polarised? Brewster states that he observed the fact in 1812. (3) Having regard to the date (1827), what were the most probable sources of information to which the writer of the poem was indebted?

Lord Tennyson kindly informs me that the poem was probably written by Charles Tennyson.

CHAS. T. WHITMELL.

Invermay, Hyde Park, Leeds, June 5.

The Mass of the α Particle.

JUST too late to prevent the publication of my letter of last week, I perceived that the arguments contained in it are valueless. Rutherford's estimation of the number of α particles is based on the assumption that the charge on each of them is ϵ, and cannot be used to prove that proposition. The numbers given only show that the heat energy radiated by radium is approximately equal to the kinetic energy of the α rays, as has been pointed out by Rutherford. I regret that this foolish mistake should have led me to trespass needlessly upon your valuable space.

NORMAN R. CAMPBELL.

Trinity College, Cambridge, June 14.

Animal Messmates.

WHILE searching for marine animals on January 14, I came across some large specimens of *Ciona intestinalis*, which I kept for some time in a large bottle. After a while I noticed a small worm emerging from the larger or exhalent siphon, which, on examination by a competent authority, proved to be a small example of the nemertine worm *Drepanophorus rubrostriatus* = *Amphiporus spectabilis*, Qtrf. Other worms of the same species afterwards emerged, about ten being observed altogether. The Ciona betrayed no apparent annoyance at the egress or return of the creatures, though it withdrew its siphons at the slightest touch of any foreign objects. This observation seems to be a new instance of "animal messmates," or at any rate of the use of an ascidian's test for purposes of shelter by an active creature.

This has been confirmed on several subsequent occasions by myself and others; in one instance, a small Ciona, from which not fewer, but possibly more, than fifteen worms issued, the creature was so transparent that the worms could be observed moving about in its interior.

FRANK S. WRIGHT.

Guernsey, June 10.

Decomposition of Radium Bromide.

WITH reference to Prof. Porter's note in NATURE of June 13 (p. 151) on the odour of bromine detected on opening a sealed tube of radium bromide, it appears that the minimum quantity of bromine that is detectable by smell is between the orders 10^{-8} to 10^{-10} grams per cubic centimetre of air. This result has been obtained by the progressive dilution of a definite volume of bromine vapour. It may be mentioned that the vapour of bromine is just detectable by its odour at the temperature of liquid air.

ALFRED C. G. EGERTON.

University College, London, June 17.

THE DESTINY OF MAN.[1]

THE present volume contains three essays reprinted from two recent addresses and one article by the author. They have been slightly modified and freely illustrated for the present purpose. The first essay, "Nature's Insurgent Son," was delivered as the Romanes lecture at Oxford in 1905. It traces the history of man and his rebellion against nature, shows that his inevitable destiny is to transform rebellion into conquest, points to the causes of delay and the special responsibility for their removal which belongs to our universities.

The second essay, "The Advance of Science," served as the presidential address to the British Association at York in 1906. It gives an account of man's campaign against nature during the last twenty-five years. It is triumphantly successful in the difficult feat of rendering supremely interesting a brief general account of advance in all the great departments of science.

The third essay, "The Sleeping Sickness," reprinted from the *Quarterly Review*, gives an account of this recent terrible scourge of tropical Africa, and the attempts which have been made to deal with it. This essay is the other side of the picture presented in the second. The latter told of splendid successes in the warfare with nature; the present essay gives a startling example of those haphazard, unintelligent methods which bring terrible disaster upon man.

In attempting to give some account of this arresting and important work in the brief limits of the allotted space, I have thought it best to confine my attention to the central argument founded on man's history, rebellion and destiny. This argument, developed in the first essay, appeals strongly to the imagination, and supplies a powerful motive force which has been wanting in the case of earlier appeals for reform.

"Man is held to be a part of Nature, a product of the definite and orderly evolution which is universal; a being resulting from and driven by the one great nexus which we call Nature. He stands alone, face to face with that relentless mechanism. It is his destiny to understand and to control it."

This statement of man's origin is rightly held to contain no implied degradation—rather the reverse. It is only a superficial and ignorant view which sees in evolution the dominion of "chance." "The conclusion that Man is a part of Nature . . . is in fact a specific assertion that he is the predestined outcome of an orderly—and to a large extent 'perceptible'—mechanism." It was of importance to urge this conclusion again, a conclusion set forth, as the author states, by Tyndall in his presidential address to the British Association at Belfast in 1874, and again stated and admirably illustrated by Huxley in 1887.[2] But the error refuted in 1874 and 1887 was still alive and vigorous in 1905, and there is reason to fear that even now it is not wholly extinct.

The emergence of man—perhaps in Lower Miocene times—is shown to be the grand example of an evolution also witnessed in other animals. In many of the early Tertiary Mammalia, as well as in the ancestors of man, it is probable that mechanical form and function had reached a climax. From this point the struggle was conducted and evolution proceeded on a higher plane, and led to progressive increase in the size and powers of the brain. The author suggests the convincing hypothesis[3] that this sudden growth in the bulk of brain-substance—in animals as well as in ancestral man—signifies the substitution in large part of "educability" for a life controlled by inborn hereditary nervous mechanisms. An increased power of storing up and profiting by individual experience takes the place of all but the most fundamental and essential instinctive actions which are the inevitable outcome of inherited brain-structure. "The result is that the creature called Man emerged with an educable brain of some five or six times the bulk (in proportion to his size and weight) of that of any other surviving Simian." One of the most astonishing facts in this history is that so much of it was accomplished by early Palæolithic times, so that from this period to the present day "the bulk of his brain does not appear to have continued to increase in any very marked degree." We must, however, remember, as indeed the author reminds us, that Palæolithic man was probably not much more monkey-like than some of the existing savage races. The best implements of that age "are manufactured with great skill and artistic feeling"; they certainly go beyond the bare necessities of use as weapons or tools, and imply a life of immense complexity as compared with that of the highest animal. Although the subsequent increase in cranial capacity is surprisingly small, it is admirably shown, by two pairs of figures, to be very significant. By the courtesy of the publishers these illustrations are here reproduced. The first pair of figures, together forming the frontispiece of the work, represent above the cranial dome of Pithecanthropus, below the skull of a Greek, both seen from the left side. The former differs from the latter in the same features, but even more remarkably than do the Spey and the Neanderthal skulls.

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[1] "The Kingdom of Man." By E. Ray Lankester, F.R.S. Pp. xii+191. (London: Archibald Constable and Co., Ltd., 1907.) Price 3*s*. 6*d*. net.

[2] "The Life and Letters of Charles Darwin." Edited by Francis Darwin. Vol. ii., Chapter v., Prof. Huxley on the reception of the "Origin of Species," pp. 109–201.

[3] First published in "Cinquantenaire de la Société de Biologie." Pp. 48–51. (Paris, 1877.)

"The three great features of difference are: (1) the great size of the eyebrow ridges (the part below and in front of A in the figures) in the Java skull; (2) the much greater relative height of the middle and back part of the cranial dome (lines *e* and *f*) in the Greek skull; (3) the much greater prominence in the Greek skull of the front part of the cranial dome—the prefrontal area or frontal 'boss' (the part in front of the line AC, the depth of which is shown by the line *d*)."

"The parts of the cranial cavity thus obviously more capacious in the Greek skull are precisely those which are small in the Apes and overlie those convolutions of the brain which have been specially developed in Man as compared with the highest Apes."

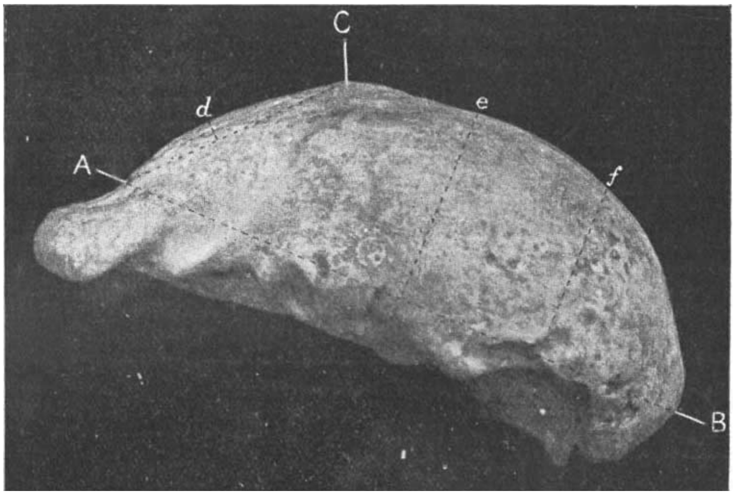

FIG. 1.—Cranial Dome of *Pithecanthropus erectus* from river gravel in Java. From "The Kingdom of Man."

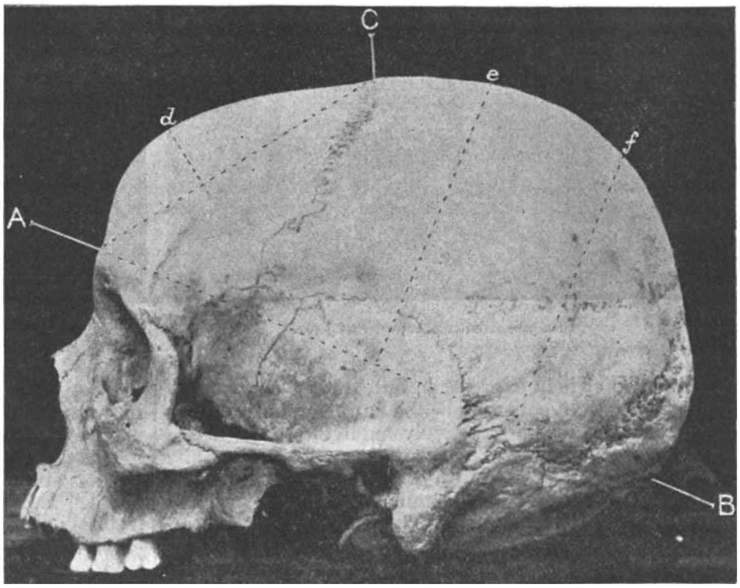

FIG. 2.—Skull of a Greek from an Ancient Cemetery. From "The Kingdom of Man."

It is necessary to add a few sentences in explanation of the simple but extremely efficient set of lines by which the important differences between the skulls are indicated and can be assigned a quantitative value. The line A–B, in both skulls, is drawn from ophryon (the median point of a line drawn across the narrowest part of the frontal bone) to the extra-tentorial point between the occipital ridges. A–B thus practically represents the base-line of the cerebrum. Lines *e* and *f* are perpendiculars drawn respectively from the median point of A–B and the junction of the third with the posterior fourth of the same line.

The development of the frontal boss is clearly shown by the line A–C drawn from ophryon to bregma—the point of contact of frontal with both parietal bones. Line *d* is a perpendicular drawn from A–C to the most prominent point of the frontal boss.

The line A–B may be divided into units, and the lines *d*, *e*, *f*, indicating the depth of the brain-cavity at these three important points, expressed numerically as percentages of the ophryo-tentorial length.

The full significance of this method of comparison is only realised when the figures already described are considered in relation to those reproduced on the next page, Fig. 3, of course, corresponding to the upper, Fig. 4 to the lower of the preceding pair. It is here shown that line A–C—appearing as a straight line when the skulls were looked at from a little distance and placed so as to give an accurate side view—becomes when seen in front view the ovoid outline of the base of the frontal boss—the line where the frontal bone is cut by a plane at right angles to the sagittal plane, and passing through both ophryon and bregma. Similarly the line *d*, straight in the previous figures, becomes in front view the (white) line across the greatest breadth of the frontal boss. The astonishing difference between the size of this boss or prefrontal area in Pithecanthropus and that of the Greek skull is perhaps even more evident in these than it was in the former figures.

It should be mentioned that the Greek skull was selected because it happened to be a favourable example suitable for photographic reproduction, and not because of any special superiority in the crania from south-eastern Europe. Were it otherwise the author's illustrations might perhaps be called as evidence in favour of compulsory Greek!

We have directed special attention to these four figures because by their means the essential differences between the earliest known and the latest human crania are so clearly expressed; but, after all, the most striking fact that emerges is the immense size of the ancient brain and the relatively small increase which has since occurred. "The cranial capacity of many savage races and of some of the most ancient human skulls is only a little less than that of the average man of highly-civilised race. The value of the mental activities in which primitive man differs from the highest apes may be measured in some degree by the difference in the size of the man's and the ape's brain; but the difference in the size of the brain of Isaac Newton and an Australian black-fellow is not in the remotest degree proportionate to the difference in their mental qualities. Man, it would seem, at a very remote period attained the extraordinary development of brain which marked him off from the rest of the animal world, but has ever since been developing the powers and qualities of this organ without increasing its size, or materially altering in other bodily features."

It must, however, be again pointed out that, as the author states, these earliest human crania are probably Palæolithic, and thus belong to an advanced stage of human evolution with conditions not very different from those of certain savage races both existing and extinct within recent years.

The rise of the mind of man has finally led to a new "power in Nature, an *imperium in imperio*, which has profoundly modified not only man's own history but that of the whole living world and the face of the planet on which he exists." He has become "Nature's rebel," and "where Nature says 'Die!' Man says 'I will live.'" Finally, "he has advanced so far and become so unfitted to the earlier rule, that to suppose Man can 'return to Nature' is as unreasonable as to suppose that an adult animal can return to its mother's womb." But if man cannot go back he can go forward, and the author urges "the conscious and deliberate assumption of his kingdom by Man—not as a matter of markets and of increased opportunity for the cosmopolitan dealers in finance—but as an absolute duty, the fulfilment of Man's destiny, a necessity the incidence of which can only be deferred and not avoided."

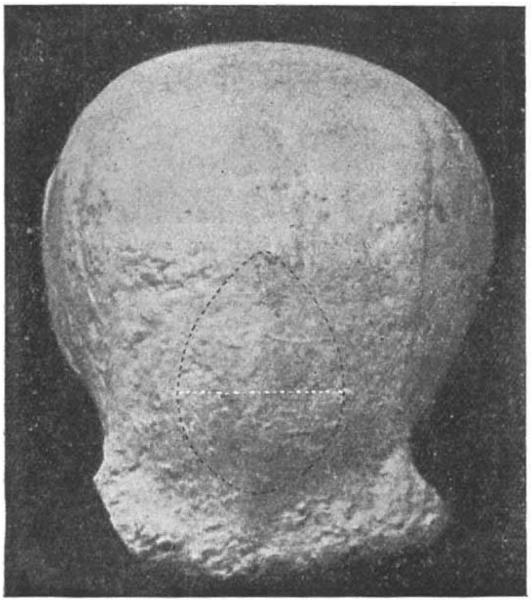

Fig. 3.—Pithecanthropus from Java.

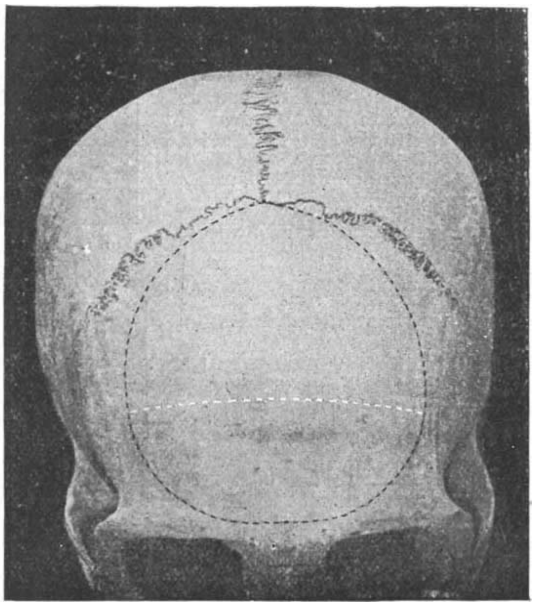

Fig. 4.—Greek Skull.

From "The Kingdom of Man."

After tracing some of the chief lines in the past and urging the necessity for determined and active progress, the author proceeds to consider the causes of man's delay. These are found to spring from ignorance of the situation on the part of the masses of the people; and it is rightly argued that when the inevitable light shall have dawned the democracy will insist on very different qualifications in its public servants. The essay concludes by calling on the University of Oxford not to wait for the pressure that will surely come, but to take a foremost part in equipping mankind for further victories and a speedy entrance into the kingdom; and in order to play this splendid part, our ancient university is reminded that no new attitude towards learning is required, but a return to the old academic spirit which laid in Oxford the foundation of the Royal Society—this, together with some relaxation of the grip of the "present curriculum, . . . a mere mushroom growth of the last century."

It is astonishingly difficult to induce mankind to adopt fundamental changes in the methods of education. The results of education, although of boundless practical importance, are not immediately recognisable by those whose imagination has been stunted by the methods employed in their own youth. An inadequate cramping education tends to prolong itself; for youth, with all its hidden powers calling for development, must submit to the methods imposed by age. It is probable that no branch of the human race is more difficult to move than our own. The thought sometimes arises that salvation can only be found, if at all, by national disaster; and then, under modern conditions, the remedy may be too late and recovery impossible. About forty years ago Huxley delivered the powerful and eloquent addresses on education reprinted in "Lay Sermons, Addresses, and Reviews," and yet the same subject is felt to be still the paramount question of the hour when one of our foremost scientific men is invited to deliver the Romanes lecture in 1905. It is disheartening to read Huxley's admirable and convincing essays and to realise how small has been the effect. But a reformer who would achieve anything must not give way to despondency: it is only by hope and confidence in the future that mankind can be moved. And this latest appeal has one great advantage over the old. The history of man could not have been spoken of forty years ago as it can to-day; his interference with nature is also far more evident. In this latest appeal, the imagination of the author aroused by these considerations has originated the splendid argument founded on the deeds, the delay, and yet, in spite of delay, the inevitable triumphant destiny of man. It is not too much to hope that the power and the onward sweep of this great argument will carry away many an old but not time-honoured barrier, and many an obstacle built up, alas, in modern times, intervening between man and the race that is set before him. E. B. P.

INTERNATIONAL ASSOCIATION OF ACADEMIES.

A BRIEF note on the third triennial general assembly appeared in NATURE for May 30. The following academies were represented:—Amsterdam, Berlin, Brussels, Budapest, Christiania, Göttingen, Copenhagen, Leipzig, London (R.Soc.), London (B.Acad.), Madrid, Munich, Paris (Belles-Lettres), Paris (Sciences), Paris (Morales et Politiques), St. Petersburg, Rome, Stockholm, Tokio, Washington, Vienna. The English representatives mentioned in NATURE for May 30 were all present with the exception of Sir Norman Lockyer.

Turner

The proceedings opened on the morning of May 29 with a brief address from Prof. Suess, the president. Dr. Böhm-Bawerk (Vienna) was nominated vice-president, and the following as secretaries:—German, Gomperz (Vienna), von Lang (Vienna); French, de Lapparent (Paris), Senart (Paris); English, Turner (London), Gollancz (London).

M. Darboux (Paris) then announced that a medal had been struck by the French Government in honour of the first meeting at Paris. He presented the first copy to the Vienna Academy, and said that a copy would be sent to each constituent academy. The assembled representatives of science had been pictured on the medal as young girls, and, though scarcely in accord with the appearances round him at the moment, this representation had at least the merit of suggesting that science was always young.

It was decided by small majorities not to place on the agenda paper either the selection of an auxiliary language or the proposal for a symbolic nomenclature for machinery. Other questions dealt with at this meeting related to statutes and procedure.

On Thursday, May 30, the association met in two sections. In the section of science the report of the Brain Commission was received and placed on the minutes, no vote of approval being necessary since this commission has autonomous powers. A committee appointed in 1904 by the association to "consider the best method of bringing existing organisations into relation with the association" reported that they had made certain suggestions to the International Seismological Association which had been adopted, and that in consequence it had become possible for the United States, Austria, and England to join that association, while the adhesion of France was confidently expected.

Sir George Darwin presented a report on the possible cooperation of the International Geodetic Association in geological researches, by means of the study of anomalies in the value of gravity. There were difficulties (especially from lack of funds) in organising such cooperation; but the apparatus of Baron Eötvös seemed likely to give just the information desired, and it was to be hoped that the Hungarian Government would encourage experiments with this apparatus.

Prof. von Than announced that the Hungarian Government had promised a sum of 60,000 kronen annually for three years for work with the apparatus of Baron Eötvös. This announcement was naturally received with acclamation, and it was resolved to tender cordial thanks to the Hungarian Government. It was also decided to represent to the Italian Government the great importance of similar researches in the neighbourhood of active volcanoes such as Vesuvius.

A report by M. Ch. Lallemand on levelling operations urged the desirability of repeating precise levellings two or three times per century in all countries, in order to determine possible changes.

As bearing on the general importance of the work of the Geodetic Association, M. Darboux referred to the work of Prof. Milne in directing attention to the possible connection between variation of latitude and seismic phenomena.

With regard to the survey of the 30th meridian of longitude, Sir G. Darwin was able to report, on the authority of Sir David Gill, that the survey was now approaching the northern limits of British territory, where it was hoped that it would be taken over by Germany and carried through German territory. Further, that there was a good prospect that certain R.E. officers would be able to survey 2° of the meridian, in the neighbourhood of the Equator, and that Captain Lyons, F.R.S., the director of the Egyptian Survey, was hoping to begin the triangulation of the Nile Valley in the coming winter.

An interesting report of the Marey Institute was received, including the announcement of munificent assistance from the French Government and the city of Paris. Here again the Association hastened to tender cordial thanks for generous Government aid to science.

The proposal of the Royal Society for a committee on lunar nomenclature was adopted without opposition; and the following were nominated to serve on the committee, with power to add to their number:—Lœwy (chairman), Newcomb, Weiss, Franz, Saunder, and Turner.

The International Union for Solar Research successfully solicited the patronage of the association, in token whereof they were to report to it every three years, and to reserve one place on the executive committee (of three members) for a member to be nominated by the leading academy for the time being. It was unanimously decided, on the motion of Prof. Hale (Washington), respectfully to invite the Austrian